Pacific Herring Coded Wire Tagging Study: 1999 Releases Recovered in 2000

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ABSTRACT

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Midterm results of a Pacific herring coded wire tag (CWT) and release program which started in 1999 are discussed in association with one year at large tag recoveries from year 2000 roe fisheries on the BC coast. In March of 1999 approximately 50,000 tags were applied from 16 seine sets in the Strait of Georgia and 5 sets in the Queen Charlotte Islands. Records are presented for 47,712 tag releases in the Strait of Georgia and 6175 tag releases in the Queen Charlotte Islands.

Two CWT detectors, each at a different Vancouver processing plant, were used for the first time in 2000 to search roe herring in BC. Approximately 6,700 tons of roe herring were searched by the 2 recovery systems, comprising about 23% of the BC roe herring catch. Sample proportions representing screening efforts for individual herring stock assessment regions were higher for the 3 southern areas (the Strait of Georgia, west coast of Vancouver Island and the Central Coast), ranging from 23.6% to 31.5%, while for the two northern areas (the Prince Rupert District and Queen Charlotte Islands) only about 10% of the catch was searched for CWTs. CWT recovery efforts provided 109 tags that could be related to year 1999 releases and year 2000 capture locations.

There were 3 especially notable recoveries from 1999 releases. Two tagged herring released in the Strait of Georgia were recovered in 2000 from Sydney Inlet on the West Coast of Vancouver Island and one of the tagged herring from the Queen Charlotte Islands was recovered in East Higgins Pass in the Central Coast. The remaining 106 herring CWT recoveries from the Strait of Georgia and Queen Charlotte Islands were released and recovered within the same vicinities.

The 109 tags recovered in 2000 represent a 1.6% coastwide recovery rate per tonne of fish searched whereas the recovery rate per tonne of herring harvested was about 0.37%. The relative effectiveness of acquiring recoveries from 1999/2000 efforts was compared with two other herring tag recapture programs and current recovery rates are considered effectively high.

Other pertinent topics discussed in the report include fish handling methods and field conditions of tagging efforts and recovering tagged fish.

RÉSUMÉ

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Nous examinons les résultats à mi-parcours d'un programme de lâcher après marquage (micromarques codées) de harengs du Pacifique, lancé en 1999, en regard des récupérations de poissons marqués, un an après le lâcher, dans les pêches de hareng rogué menées en 2000 sur les côtes de la Colombie-Britannique. En mars 1999, environ 50 000 marques avaient été implantées chez des harengs capturés dans 16 coups de senne dans le détroit de Georgia et 5 coups de senne dans les Îles de la Reine-Charlotte. Nous présentons les données concernant 47 712 lâchers dans le détroit de Georgia et 6 175 lâchers dans les Îles de la Reine-Charlotte.

Deux détecteurs de micromarques codées, installés chacun dans une usine de transformation de Vancouver, ont été appliqués pour la première fois en 2000 au hareng rogué en Colombie-Britannique. Les deux systèmes ont passé approximativement 6 700 tonnes de hareng rogué, ce qui correspond à environ 23 % des prises. Les proportions des échantillons examinés correspondant aux différentes régions d'évaluation des stocks de hareng étaient plus élevées pour les trois régions du sud (détroit de Georgia, côte ouest de l'île de Vancouver et centre de la côte), où elles se situaient entre 23,6 % et 31,5 %, tandis que seulement 10 % environ des prises des deux régions du nord (district de Prince Rupert et Îles de la Reine-Charlotte) ont été soumises aux détecteurs. L'opération de détection a permis de récupérer 109 marques qui ont pu être mises en rapport avec les lâchers de 1999 et les lieux de capture de 2000.

Trois récupérations de marques implantées en 1999 étaient particulièrement notables : deux harengs marqués lâchés dans le détroit de Georgia ont été récupérés en 2000 dans le bras Sydney, sur la côte ouest de l'île de Vancouver, et un hareng marqué aux Îles de la Reine-Charlotte a été repris dans la passe East Higgins (centre de la côte). Les 106 autres harengs du détroit de Georgia et des Îles de la Reine-Charlotte ont été marqués et récupérés dans les mêmes parages.

Les 109 marques récupérées en 2000 correspondent à un taux de récupération de 1,6 % à l'échelle de la côte par tonne de poisson soumis aux détecteurs, tandis que le taux de récupération par tonne de hareng capturé était de 0,37 %. Nous avons comparé l'efficacité relative des opérations de récupération de 1999/2000 à celle de deux autres programmes de marquage-recapture du hareng ; le taux de récupération actuel est considéré comme plutôt élevé.

Les autres sujets pertinents abordés dans le rapport sont les méthodes de manutention du poisson et les conditions qui règnent sur le terrain pendant les opérations de marquage et de récupération des poissons.

INTRODUCTION

The objective of this report is to summarise midterm results of a herring coded wire tag (CWT) program. The program began as a feasibility study in 1999 to evaluate the application and recovery of CWTs for Pacific herring. This study represents part of a larger effort to investigate herring stock structure with a combination of genetic analysis and tagging. The scope of this report includes the outcomes from tagging herring in 1999 and all of the 1999 tags that were recovered from herring harvested in the year 2000.

The 1999 herring spawning season was the first time that CWTs were applied on a large scale to Pacific herring on the coast of British Columbia. A core crew of 5 individuals partook in all the fieldwork with 2 people designated to conduct all the tag insertions and 3 people to operate the fishing gear and assist with fish handling during tagging sessions. Tagging was done in the Strait of Georgia (SG) and Queen Charlotte Islands (QCI) herring assessment regions. All SG tagging events were conducted aboard the 15m research vessel, the Walker Rock. This vessel was also used to capture small quantities (2 tonnes or less) of spawning herring in less than 10m of water using a 220m long by 27m deep purse seine with marquisette webbing in the bunt. Another vessel called the Pacific Discovery assisted the Walker Rock in the southern SG by catching fish using deeper nets. In the QCI, fish were captured by and tagged aboard the test fishing vessel the Nimpkish Producer. Initial herring holding experiments in sea water tanks were also conducted to monitor short term tag retention and mortality effects from tag placement. Information related to those efforts will be documented elsewhere.

Several combinations of herring handling and tagging methods were used in 1999. Fish were tagged using Northwest Marine Technology (NMT) Mark IV model CWT machines with 3.5 inch long tagging needles, 1.5 to 2 mm long CWTs and trigger buttons operated by foot or knee. After herring were seined, holding pens were used to concentrate herring next to the boat to facilitate dipnetting batches of 60 – 100 herring for tagging. Holding pens were either made from the seine bunt webbing or in some cases cylindrical accessory pens were used (1.8 – 3m in diameter and 2 – 3m deep). Some batches of herring were anaesthetised with 100 ppm of tricaine methosulfonate (MS222) or 150 ppm of clove oil. Tags were inserted into the dorsal musculature tissue at one of two locations: behind the skull or next to the dorsal fin, referred to as the neck and back sites respectively. Tagged fish were released into a recovery pen to promote re-schooling and to try to protect tagged herring against predators. The recovery pen was 1.8m square on top, tapering to 1.2m square on the bottom. It was made of a perforated canvas material with two 30cm square escape flaps.

The DFO Salmon Mark Recovery Program provided all the CWTs from their collection of unused tag spools. Since coded tag batches cannot be reused for salmon work, the opportunity to use a large supply of conveniently available CWTs for herring was both economical and practical.

The year 2000 was the first year that British Columbia roe herring harvests prospectively containing herring with CWTs were searched. Each recovery unit consists of an R9500 Detector supplied by NMT, a conveyer belt, support manifold and deflector gate system which were designed and built by an engineer for the purposes of automating the recoveries of CWT herring from processing plants. To guide fish through the R9500 Detector, the assembly's conveyer belt can be aligned in parallel or in series with the processing plant conveyer system. Two R9500 detectors were supplied by the DFO Salmon Mark Recovery Program. Initial plans and trials were based on the premise that herring could be effectively searched for CWTs while fish were being conveyed from vessel offloads. After the first unit was assembled, it was tested during the 1999 roe herring offloads at the Canadian Fishing Company Ltd (CFC) plant in Vancouver to evaluate aspects of its performance. Plant trials were again conducted during the 1999 Special Use Herring Fishery (from Z licences) at Ocean Fisheries Limited (Ricemill Rd, Richmond) to further test recovery performance and to consider equipment modifications, following which, a second unit was constructed.

During the 2000 roe fisheries it became apparent that recovery logistics would be improved by searching fish carcasses conveyed after fish are processed (following the "popping" of roe) rather than during vessel offloading. Apparent benefits of screening herring during processing activities were that the slower processing conveyer rates probably meant that more thorough and extensive searching could be done with less stress on staff and equipment. J.O. Thomas staff were responsible for collecting samples of recovered herring, determining associated catch data for each recovery and analysing all fish recoveries for CWT information. Operations at the CFC plant and at Icicle Seafoods Inc (Icicle) accommodated the recovery units and the J.O. Thomas staff.

The recovery units operated throughout the period of roe popping conducted at each plant. At Icicle this period was from April 3rd to June 14th and at CFC the period was from April 10th to June 14th.

RESULTS

TAGGING IN 1999

In 1999, 53,887 tags were released in the SG and QCI stock assessment regions (Figures 1 to 3). In total, twenty-three seine sets collected herring between March 2nd and 28th and 22 different tag codes were used. Summary information for the 1999 field efforts for tagging Pacific herring are outlined in Tables 1 and 2. Tag code discrepancies between a group of 3,310 fish tagged and released at French Creek and 2,505 fish tagged and released near Link Island (Stuart Channel), resulted from mislabelled tag spools. A corrected total of 48,072 with distinguishable tag codes were available from the 1999 taggings. Of this total, 41,897 tagged herring were released in the SG and 6,175 tagged herring were released near Wanderer Island in the QCI.

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Haegele and Armstrong (1999) reported the information in the following paragraphs describing the details of the SG and QCI 1999 tagging efforts and field conditions.

Increased signs of fish stress resulted from pen holding and handling exposure such that fish gradually became less slimy and lost more scales with time. For fish held in the small-mesh seine of the Walker Rock, sea state was the major factor affecting the length of time herring could be kept in good condition. In calm weather, it was noted that fish could be held for 4 hours before there appeared to be much scale loss or that fish felt 'dry' to the touch. This decreased to about 2 hours for a 2 ft chop. Under average environmental conditions, up to three hours of tagging was considered a workable time period for one set (one tagging shift) to prevent over stressing fish and to respect the endurance of taggers. One or two tagging shifts were done in a one-day period.

STRAIT OF GEORGIA (SG) TAGGING

Herring were tagged from 13 sets made by the Walker Rock and 3 sets made by the Pacific Discovery (Figures 1 and 2). Spawning occurred in two waves during the period of the project with additional spawning thereafter. March 1-10, herring spawned from south of Comox to north of Qualicum. March 14-21, herring spawned from Qualicum to Newcastle Island and north of Comox. Herring captured by the Walker Rock were either spawning or within one day of spawning, while herring captured south of Dodds Narrows (Link Island) by the Pacific Discovery were several days from spawning. The seas were generally calm during tagging, except for set 8 (Chrome Island) where strong winds developed and tagging had to be terminated after 1 hour and 20 minutes. Sea lions occurred at all the sites but were actively swimming near the boat at only three sites (and may have been feeding on some of the herring exiting the recovery pen). In Departure Bay one seal was observed thrusting its head into the flap of the recovery pen. Marine mammals in close proximity of the vessel were deterred with the delivery of sea lion bombs. Birds were present in large numbers only at set 10 (Jesse Island), where gulls were observed removing about 50 tagged herring after they had left the recovery pen. These fish had been anaesthetised for tagging.

Tagging rates were higher for anaesthetised fish and higher for the back location (Table 2). The maximum tagging rate per machine while using MS222 was approximately 700 tags / hr for the back location and approximately 550 tags / hr for the neck location. Tagging rates without anaesthetic reached up to approximately 600 tags / hr for the back location and approximately 450 tags / hr for the neck location. Fish that were transferred from the commercial seine of the Pacific Discovery to the holding pen, a procedure which took about 1 hour, generally had 10-20% scale loss.

QUEEN CHARLOTTE ISLAND (QCI) TAGGING

Herring were tagged from 3 sets in close proximity to Wanderer Island around Centre Island in the QCI (Table 1, Figure 3). A total of 6175 tagged herring were released, all tagged in the back using MS222 for anaesthetic (Table 2). The tagging rate was similar to that obtained in the SG for this combination of tag location and anaesthetic. It took between 1 to 2 hours to dry up the seine and between 12 and 54 dips to transfer fish to the holding pen with a dipnet. Scale loss ranged from 5% to 30% for individual fish. Wind and a dragging anchor shortened the time available for tagging on some sets.

Additional tagging opportunities were missed in the Queen Charlotte Islands because of: (1) concerns about possible conflicts with the spawn-on-kelp fishery in Selwyn Inlet; (2) spawning fish in shallow water in Skincuttle Inlet could not be obtained by the Nimpkish Producer's deeper commercial herring seine and (3) there was an implicit DFO policy not to disturb fish near a spawn-on-kelp pond at Nomad Islet.

RECOVERIES IN 2000

In total, 119 of the 53,887 tagged herring that were released in 1999 were recovered in 2000 but unfortunately 10 of these have SG release sites that cannot be distinguished between Link Island and French Creek (Table 1). However the 10 respective recovery sites were from the SG (Lower Baynes Sound region). Further reporting of results in this report omits release and recovery data associated with these 10 discrepancies, leaving 109 valid 1999 recoveries for analysis. Seventy of the recoveries were from gillnet vessels and 39 were from seine gear.

According to industry reports for CFC and Icicle landings and processing activities, 7,164 tonnes of commercial roe herring were offloaded into 151 bins, and processed at the CFC and Icicle plants combined where the CWT recovery units were in operation. It was estimated that 6,711 tonnes of the landed harvests at these plants were searched with recovery equipment, thus approximately 94% of the fish processed at these plants were searched for CWTs (Table 3). The difference of 430 tonnes (estimated at 6% between landed harvests received by the 2 plants and the amounts that were searched for CWTs) was due to a combination of occurrences. Firstly, fish from several small lots from other fishery pools were received at the plants without screening. Secondly, 3 days of screening were lost due to equipment failure. Thirdly, some product shrinkage and weight loss would have occurred during brine processing.

An average of 23% of all the commercial roe catch along the BC coast in year 2000 was searched by the recovery systems. This is a reasonable sample of the total landings. Sample proportions representing recovery efforts per management region harvests at the two processing plants were higher for the 3 southern areas (SG, west coast of Vancouver Island and Central Coast), ranging from 23.6% to 31.5%,

while for the two northern areas only about 10% of the catch was searched for CWTs (Table 3).

All 1999 tag releases and recoveries are shown in Figures 1 to 4. Within the SG it is evident that some movement of fish occurred from 1999 to 2000 with recoveries of fish from most of the tag releases occurring in the Lambert Channel fishery. On average an estimated coastwide recovery rate of 0.23% for the direct number of recoveries per number released was derived (Table 4); whereas averages of 0.25% and 0.08% were attained for the SG and QCI respectively . Adjusted recovery rates were derived to account for the percent of the commercial catch that was searched by detector systems. The adjusted coastwide recovery rate estimate for the number of recoveries per number of releases was about equal to individual estimates for both the SG and QCI, at about 1.00% (Table 4). The 109 tags recovered in 2000 represent a 1.6% coastwide recovery rate per tonne of fish searched whereas the recovery rate per tonne of herring harvested was about 0.37% (Table 5).

Each time a recovery system was tripped during the screening of herring at the processing plants a quantity of fish pieces (5 to 30) was diverted into a tote. All prospective carcasses were then individually checked using a hand held CWT wand detector. It was estimated that some 70,000 herring pieces were manually searched to recover the CWTs in 2000. As well as the 1999 tag releases, about 400 same season recoveries occurred from 2000 SG releases that preceded or overlapped with days when commercial harvests were occurring. In addition to the resolved recoveries described above, there were about 700 instances of false alarms of the detectors at the two plants combined. Further investigation into test trials and the associated fish showed contamination from metallic substances. During some of the initial tests of the detection system paint flecks attached to fish (from the plant floors) were sufficient to set off the tag detection system. Furthermore, during the roe processing operations we observed bits of metal, either rust or paint flecks, becoming stuck in the gills of the herring. In addition, several instances of herring with metallic pebbles in their stomachs were sufficient to set off the detector.

There were 3 especially notable recoveries from 1999 releases. Two tagged herring released in the SG were recovered in 2000 from Sydney Inlet on the west coast of Vancouver Island (WCVI) and one of the tagged herring from the QCI was recovered in East Higgins Passage in the Central Coast (CC). The remaining 106 tagged herring recoveries from the SG and QCI were released and recovered within the same vicinities.

STRAIT OF GEORGIA RECOVERIES

In 2000, the SG seine fishery occurred on March 2nd and 3rd and was regionally bounded within the DFO statistical subareas of 14-5 and 14-8 (Lower Baynes Sound) whereas the SG gillnet fishery occurred from March 4th to 7th and was regionally bounded within the statistical subareas of 14-1 to 14-13 and 14-15. In total, 14,402

tonnes of roe herring were harvested in 2000 from the SG openings, 6,490 tonnes from seine and 7,912 tonnes from gillnet gear. It was estimated that 3,403 tonnes of the total SG harvests were searched by recovery equipment, approximately 23.6% of the harvest (Table 3). Of the total SG harvests, 3,736 tonnes were processed at CFC and Icicle. Table 6 presents the number of tags released in 1999 at various SG localities and the resulting recoveries from the 2000 roe herring fisheries, 102 of which were recovered in the SG. Localities are based on designated SG Sounding Areas (G. McEachen, pers. comm.).

Excluding the small sample of tags applied using the hand held tagging device, herring samples with CWTs were recovered for all tagging methods (related to body site and anaesthetic combination). Recovery proportions were consistent among SG tagging methods and ranged from 0.21 to 0.26% with respect to number of tags recovered per number of tags released for each tag insertion protocol (raw data in Tables 1 & 2).

QUEEN CHARLOTTE ISLAND RECOVERIES

In 2000, the QCI seine fishery occurred on March 15th and 16th and was regionally bounded within the statistical subareas of 2-13, 2-15 and 2-16 (Skaat Harbour and Burnaby Island). In total, 1,591 tonnes of roe herring were harvested in 2000 from the seine opening. It was estimated that 148 tonnes of the total landed QCI harvests were searched by recovery equipment, approximately 9.3% of the total landings (Table 3). From the total QCI harvests, 148.2 tonnes were processed at CFC and Icicle. All of the 1999 QCI tagging efforts were in areas near to or inside of the 2000 fisheries boundaries. Table 6 presents the number of tags released in 1999 and the 4 resulting recoveries from the 2000 QCI roe herring fisheries.

CENTRAL COAST RECOVERIES

In 2000, the CC seine fishery occurred from March 17th to 19th and was regionally bounded within statistical subareas 7-8, 7-12, 7-13 and 7-14 (Lower Spiller Channel). The gillnet fishery occurred from March 28th to 30th within statistical subareas 6-16, 6-17 and 7-3 (East Higgins Passage). In total, 7,309 tonnes of roe herring were harvested in 2000 from the CC openings, 6,319 tonnes by seine and 991 tonnes by gillnet gear. It was estimated that 2,305 tonnes of the total landed CC harvests were searched by recovery equipment, approximately 31.5% of the total landings (Table 3). From the total CC harvests, 2,417 tonnes were processed at CFC and Icicle. One recovery from QCI releases was recovered in the CC (Table 6).

WEST COAST OF VANCOUVER ISLAND RECOVERIES

In 2000, the WCVI seine fishery occurred on March 8th and 9th and was regionally bounded within subarea 23-11 and portions of subareas 23-09 and 23-10. The gillnet fishery occurred from March 21st to March 24th in subarea 25-13. In total, 1,280 tonnes of roe herring were harvested in 2000 from the WCVI openings, 531 tonnes from seine and 749 tonnes from gillnet gear. It was estimated that 356 tonnes of the total landed WCVI harvests were searched by recovery equipment, approximately 27.8% of the total catch (Table 3). From the total WCVI harvests, 362.8 tonnes were processed at CFC and Icicle. Two recoveries from SG releases were recovered in the WCVI (Table 6).

PRINCE RUPERT DISTRICT RECOVERIES

In 2000, the Prince Rupert District (PRD) seine fishery occurred on March 27th and 28th and was regionally bounded within the statistical subareas of 5-4, 5-5, and 5-9. The gillnet fishery occurred from March 29th to April 1 in subarea 3-2, 3-5, 4-5, 4-7, 4-8, 4-9 and portions of subareas 3-4, 4-6 and 4-14. In total 4,535 tonnes of roe herring were harvested in 2000 from the PRD assessment region, 1,325 tonnes from seine and 3,209 tonnes from gillnet gear. It was estimated that 499 tonnes of the total landed PRD harvests were searched by recovery equipment, approximately 11% (Table 3). From the total PRD harvests, 499.5 tonnes were processed at the CFC and Icicle plants.

DISCUSSION

In considering the current CWT program's results of recovery rates after one year at large, we can compare our results to those from two other herring tagging programs. Morrison and MacDonald (1986) report work done with Atlantic herring and CWTs off of Scotland in the Shetland region from 1983 to 1985. They report results of tagging and releasing 48,000 herring in the summer of 1983 and 10,000 herring in the summer of 1984 and obtaining recoveries from searching efforts in the summers of 1984 and 1985. In 1984, 1580 tonnes were searched using a NMT detector at a processing plant (receiving catches from 3 seine vessels) whereby 32 herring with CWTs were recovered. For the 1985 recoveries, Morrison and MacDonald report that from searching 1259 tonnes 4 herring with 1984 tags were recovered. Thus a biannual average of 0.06% for 1 year at large recoveries was derived for the number of recoveries per number of releases and an average of 1.30% for recoveries per tonne searched.

A second herring tagging program, which happens to have been the most recent herring tagging program on the BC coast prior to using CWTs, went from 1979 to 1992 and used anchor tags for 11 release years (Daniel et al. 1999; Hay et al. 1999). The highly visible anchor tags were inserted into tissue using a gun-like applicator at

either the posterior or anterior margin of the dorsal fin (Haegele et al. 1983; Haegele, 1986). Anchor-tagged herring were recovered in fish processing plants by plant crew who visibly detected the tags during manual processing efforts for all regional and seasonal herring harvests (Haegele, 1986). In considering anchor tag efforts related to one year at large herring recoveries for the 11 release years, 482 recoveries were made following 572,378 releases. The average rate for the number of recoveries per releases was estimated to be 0.08% (SD 0.05). Individual annual estimates of recovery rates, for recoveries per releases, varied from 0.0 to 0.15%, with 5 out of 11 release years having rates greater than 0.10% (Table 7). The estimated average recovery rate relating recoveries to annual catch tonnages was 0.13% (SD .14). Annual recovery rates, of recoveries per tonnage processed, varied from 0.0 to 0.42% with annual catch tonnages ranging from 16,366 to 41,035 tonnes (Schweigert and Fort, 1994).

To summarise comparisons of one-year at large recovery rates among the 3 herring programs, the BC CWT 1999/2000 efforts had the greatest proportion of recoveries based on number of releases at 0.23% (see below table). The apparent effectiveness of detecting CWT was much higher than that of detecting anchor tags based on rates of recoveries per tonnes searched. The BC and Shetland CWT recovery rates, related to tonnes searched, were quite similar (1.60% and 1.30%, respectively), and the apparent effectiveness of detecting anchor tags was much lower (0.13%).

Estimated percent recovery rates of three herring tagging programs, per number of tagged fish released (releases) or tonnes searched.

Recovery Rate	**BC CWT 1999-2000**		**Shetland / Scotland CWT 1983-1985**		**BC Anchor tags 1979-1992**	
Per release:	SG	0.25	1983	0.07	Mean	0.08
	QCI	0.08	1984	0.04	(SD	0.05)
	Coastwide	**0.23**	**Average**	**0.06**		
Per tonne searched:	SG	3.00	1983	2.00	Mean	0.13
	QCI	2.60	1984	0.31	(SD	0.14)
	Coastwide	**1.60**	**Average**	**1.30**		

Some reasons for explaining why anchor tag detection was considerably lower than CWT detection are thought to be related to a higher mortality and tag loss post anchor-tagging and that visual detection of anchor tags in the plants was less reliable than using CWT detectors. Therefore BC 2000 CWT recovery results demonstrate some effectively high recovery rates. In considering the tag recovery rates related to the 1999 releases and the fact that in year 2000 about 248,000 herring in the SG received CWTs, more than 500 CWT recoveries from 1999 and 2000 releases can be anticipated in 2001 given similar sized fisheries. One recommendation to improve coastwide coverage for 2001 tag screening is to have an additional detector strategically located to receive large portions of harvests from PRD and QCI.

Overall, our experience with coded wire tagging has been positive and it appears feasible to apply large quantities of tags in a short time period. Consistency in the relative proportions of recoveries from different tag insertion protocols is encouraging because it hints that the choice of field tagging methods may not have much impact on the survival and recovery of tagged fish. The installation of tag recovery systems after the roe popping phase of a fish plant's operation is effective for tag recovery since it is relatively straight forward to relate tags to packers or harvest vessels and to harvest locales. At this point in the CWT program one major concern is the short and long term survival of tagged fish relative to untagged herring which will be an ongoing area of research.

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The Herring Conservation and Research Society (HCRS) in conjunction with DFO provided funding for this project. Thyra Nichols and associates of Streamline Consulting provided tagging support during both 1999 and 2000. Bob Armstrong, Carl Haegele, and Doug Henderson conducted fishing and tagging operations in 1999 and 2000 and provided logistical support. Doug Miller assisted field tagging efforts by designing and manufacturing tagging machine needle supports as well as operating an ancillary vessel. Crew members of the Pacific Discovery were extremely helpful in developing a method for transferring fish from a commercial seine to a holding pen. Gordon Usher and Ray Sjolund provided water transport from Sandspit to Selwyn Inlet on a very stormy day. Doug Tallman of J.O. Thomas & Associates suggested the tag recovery system and provided logistical support for all tag recovery operations. Management and plant staff at Canadian Fishing Company Ltd, Ocean Fisheries Ltd and Icicle Seafoods Inc were extremely helpful in accommodating the operation of recovery equipment. Jim Stewart of Forward Consulting and Design Ltd designed, constructed, and supported the tag recovery systems. Doug Herriott of the Salmon Head Recovery Program provided unused CWTs, loan of two R9500 tag detectors, assistance in reading CWT codes, and other logistical support. Sue Lehman of the Salmon Mark Recovery Program provided the loan of tagging machines in 1999 and 2000 and Steve Baillie of PBS provided loan of tagging machines in 2000. Funding for L. Flostrand was provided jointly by the HCRS and DFO's Youth Internship Program. Thanks to Peter Midgley for making the figures.

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Table 1. Pacific herring tagging information for 1999 by seine set, location, tag code, number of herring tagged and released (CWTs), release date, latitude and longitude of release site and relative number of year 2000 recoveries.

Set	Location	CWT code	CWTs	Date	Latitude	Longitude	Recoveries	Comments
Georgia Strait:								
1	Fillongley Park	18-08-28	2587	2-Mar-99 49	31.943 124	45.068	0	
2	Whalebone Point	18-08-56	3751	4-Mar-99 49	30.150 124	43.590	13	
3	Phipps Point	18-15-63	1857	4-Mar-99 49	31.468 124	42.772	4	
4	Bowser	02-60-10	3006	5-Mar-99 49	25.879 124	39.378	10	
5	Qualicum Bay-1	18-12-33	3590	6-Mar-99 49	24.589 124	37.674	16	
6	Qualicum Bay-2	18-02-04	3670	6-Mar-99 49	24.679 124	37.623	10	
7	Metcalfe Bay	18-14-34	675	7-Mar-99 49	29.544 124	45.701	0	
8	Chrome Island	18-12-35	1644	9-Mar-99 49	28.389 124	41.390	10	
9	Link Island-1	18-12-07	1964	15-Mar-99 49	6.725 123	45.863	9	
10	Jesse Island	02-63-44	3597	15-Mar-99 49	12.573 123	56.986	6	
11	McKay Point	18-12-34	3370	16-Mar-99 49	11.982 123	55.405	8	
12*	Link Island-2	(18-12-32)	(2505)	18-Mar-99 49	6.581 123	45.686	(3)	*code discrepancy with 18-12-13 (French Creek)
12	Link Island-2	18-38-12	760	18-Mar-99 49	6.581 123	45.686	0	
12	Link Island-2	08-24-19	153	18-Mar-99 49	6.581 123	45.686	0	153 tags applied during hand held tagging trials
13*	French Creek-1	(18-12-13)	(3310)	18-Mar-99 49	20.758 124	21.145	(7)	*code discrepancy with 18-12-32 (Link Island)
14	French Creek-2	08-16-11	3438	19-Mar-99 49	20.754 124	21.037	4	
15	French Creek-3	02-19-27	3413	19-Mar-99 49	20.561 124	20.449	8	
16	Link Island-3	08-16-09	4422	20-Mar-99 49	6.640 123	46.399	6	
Subtotal (with discrepancies):			(47,712)					
Without discrepancies:			41,897					
Queen Charlotte Islands:								
21	Wanderer Is-1	18-02-25	1141	26-Mar-99 52	24.772 131	24.076	0	
22	Wanderer Is-2	18-11-50	1082	27-Mar-99 52	24.858 131	23.752	0	
22	Wanderer Is-2	18-11-55	920	27-Mar-99 52	24.858 131	23.752	1	
23	Wanderer Is-3	18-18-34	1600	28-Mar-99 52	24.870 131	23.840	1	
23	Wanderer Is-3	18-14-16	1432	28-Mar-99 52	24.870 131	23.840	3	
Subtotal			6175					
Total (with discrepancies):			(53,887)				(119)	
Without discrepancies:			48,072				109	

Table 2. Pacific herring tagging information for 1999 by seine set, location, catcher vessel, conditions, predators, spawning activity, anaesthetic used, body site of tag placement, time of day, duration of tagging shift (hours) and average tagging rate (CWTs/hr/machine).

Set	Location	Catcher vessel	Conditions	Predators	Spawning activity	Anaesthetic	Body site	PST	Hours	Tagging rate
Georgia Strait:										
1	Fillongley Park	Walker Rock	calm, snow	none	active at site	MS222	neck	15:50	4.17	310
2	Whalebone Point	Walker Rock	calm, sunny	none	active at site	MS222	back	07:00	4.50	417
3	Phipps Point	Walker Rock	ripple,clear	none	active at site	none	back	16:00	2.67	348
4	Bowser	Walker Rock	calm, sunny	none	active at site	none	neck	10:45	4.00	376
5	Qualicum Bay-1	Walker Rock	calm, sunny	none	active at site	MS222	neck	09:45	3.25	552
6	Qualicum Bay-2	Walker Rock	calm, sunny	none	active at site	MS222	back	14:00	3.00	612
7	Metcalfe Bay	Walker Rock	chop, overcast	none	in vicinity	none	neck	11:30	0.83	405
8	Chrome Island	Walker Rock	chop, overcast	none	in vicinity	none	back	11:30	1.33	617
9	Link Island-1	Pacific Discovery	calm, overcast	sea lion	none in area	MS222	neck	05:15	1.83	536
10	Jesse Island	Walker Rock	chop, overcast	gulls	next day in season	MS222	neck	14:30	4.00	450
11	McKay Point	Walker Rock	calm, clear	sea lions	next day at site	none	neck	16:00	3.67	460
*12	*Link Island-2	Pacific Discovery	calm, overcast	sea lions	none in area	none	neck	06:00	3.42	478
12	Link Island-2	Pacific Discovery	calm, overcast	sea lions	none in area	none	neck	06:00	3.42	478
*13	*French Creek-1	Walker Rock	calm, showers	none	active at site	clove oil	back	17:00	2.50	662
14	French Creek-2	Walker Rock	calm, overcast	none	active at site	none	back	06:45	2.92	589
15	French Creek-3	Walker Rock	calm, sunny	none	active at site	MS222	back	11:30	2.00	853
16	Link Island-3	Pacific Discovery	calm, sunny	none	none in area	MS222	back	06:30	3.00	739
Queen Charlotte Islands:										
21	Wanderer Is-1	Nimpkish Producer	chop, snow	gulls	next week in vicinity	MS222	back	08:30	1.00	571
22	Wanderer Is-2	Nimpkish Producer	chop, snow	gulls	next week in vicinity	MS222	back	08:40	1.67	649
22	Wanderer Is-2	Nimpkish Producer	chop, snow	gulls	next week in vicinity	MS222	back	08:40	1.42	649
23	Wanderer Is-3	Nimpkish Producer	chop, hail	none	next week in vicinity	MS222	back	13:15	2.00	800
23	Wanderer Is-3	Nimpkish Producer	chop, hail	none	next week in vicinity	MS222	back	13:15	2.00	716
									Average:	554

*Release sites with discrepant CWT codes.

Table 3. Roe herring harvest results in 2000 by herring stock assessment region. Weight proportions for fish processed and searched for CWTs, measured in metric tonnes and short tons.

Assessment Region	Total catch (tonnes)	*Total Catch (tons)*	Estimated tonnes searched	*Estimated tons searched*	%Searched / catch	Tonnes processed at CFC & Icicle	*Tons processed at CFC & Icicle*	%Searched / processed
SG	14,402	*14,844*	3,403	*3508*	23.6	3736.2	*3851.3*	91
WCVI	1,280	*1,319*	356	*367*	27.8	362.8	*373.9*	98
CC	7,309	*7,534*	2,305	*2,376*	31.5	2417.0	*2491.2*	95
QCI	1,591	*1,640*	148	*152*	9.3	148.2	*152.8*	100
PRD	4,535	*4,674*	499	*514*	11.0	499.5	*514.8*	100
BC Coast	29,117	*30,011*	6,711	*6917*	23.0	7164	*7384*	94

*CFC – 2882.1 tonnes (*2970.6 tons*), Icicle – 4281.9 (*4413.4 tons*).

Table 4. Herring CWT summary data of 1999 releases recovered from year 2000 fisheries.

1999 Release Localities	Releases 1999	Recoveries 2000	Recoveries/ releases (%)	Searched/ catch (%)	Adjusted recovery rate (%)
Lower Baynes Sound	675	0	0.00	-	-
Lambert Channel	9839	27	0.27	-	-
Mapleguard Pt - Nile Creek	3006	10	0.33	-	-
Nile Creek - French Creek*	14,111	38	0.27	-	-
Neck Pt. - Dodds Narrows	6967	14	0.20	-	-
Upper Stuart Channel*	7299	15	0.21	-	-
Georgia Strait:	41,897	104	0.25	23.60	1.10
Queen Charlotte Islands:	6175	5	0.08	9.45	0.85
B.C. Coast:	48,072	109	0.23	23.10	1.00

* Excludes discrepant CWT codes.

Table 5. Herring CWT summary data of 1999 releases recovered from year 2000 fisheries by assessment region relative to catch and tonnage searched.

Locality	Recoveries	% Recoveries/ tonnes catch	% Recoveries/ tonnes searched
SG	103	0.72	3.00
WCVI	2	0.16	0.56
CC	1	0.01	0.04
QCI	4	0.25	2.70
PRD	0	N/A	N/A
BC Coast	109	0.37	1.60

Table 6. 1999 Strait of Georgia and Queen Charlotte Islands CWT herring releases and related 2000 recoveries.

1999 Release locality	**Lower Baynes Sound (Metcalfe Bay)**
1999 No. released	675
2000 No. recovered	0
2000 Recovery localities	N/A
1999 Release locality	**Lambert Channel (Fillongley, Whalebone Pt, Phipps Pt & Chrome Island)**
1999 No. released	9839
2000 No. recovered	27
2000 Recovery localities	1 from Mapleguard Pt./ Nile Creek
	2 from Lambert Channel
	24 from Baynes Sound
1999 Release locality	**Mapleguard Pt. to Nile Creek (Bowser)**
1999 No. released	3006
2000 No. recovered	10
2000 Recovery localities	9 from Baynes Sound
	1 from Mapleguard Pt. / Nile Creek
1999 Release locality	**Nile Creek to French Creek (Qualicum Bay, French Creek)**
1999 No. released	14,111*
2000 No. recovered	38*
2000 Recovery localities	3 from Mapleguard Pt./Nile Creek
	3 Lambert Channel
	31 from Baynes Sound
	1 from Sydney Inlet (west coast of Vancouver Island)
1999 Release locality	**Neck Point to Dodds Narrows (Departure Bay / Newcastle Island)**
1999 No. released	6967
2000 No. recovered	14
2000 Recovery localities	10 from Baynes Sound
	4 from Lambert Channel
1999 Release locality	**Upper Stuart Channel (Link Island South of Dodds Narrows)**
1999 No. released	7299*
2000 No. recovered	15*
2000 Recovery localities	2 from Lambert Channel
	11 from Baynes Sound
	1 from Mapleguard Pt./ Nile Creek
	1 from Sydney Inlet (west coast of Vancouver Island)
1999 Release locality	**Queen Charlotte Islands (Wanderer Island area)**
1999 No. released	6175
2000 No. recovered	5
2000 Recovery localities	1 from East Higgins Passage (Central Coast)
	4 from Queen Charlotte Islands (Wanderer Island area)

* Totals exclude Link Island and French Creek discrepant tag codes.

Table 7. Summary estimates of recovery rate data for **one year at large** anchor tagging efforts 1979-1992. All anchor tag detection was done via visual screening at processing plants. Release and recovery data for 1 year at large recovery rate estimates were taken from Hay et al (1999,Tables 3 and 4). Catch data taken from Schweigert and Fort (1994,Tables 2.2 and 2.3).

Release year	Number released	Number recovered	Catch (tonnes)	Recovery/ Release(%)	Recovery/ tonne(%)
1979	3554	4	17079	0.113	0.023
1980	75233	38	31436	0.051	0.121
1981	114099	135	32274	0.120	0.418
1982	72097	47	37030	0.065	0.127
1983	56748	9	33250	0.016	0.027
1985	8900	3	16366	0.034	0.018
1986	8969	0	37234	0.000	0.000
1988	10741	12	41035	0.111	0.029
1989	68844	71	40351	0.103	0.176
1990	96671	141	39322	0.150	0.359
1991	56522	22	35765	0.039	0.062
Sum	572378	482	361142	0.920	1.400
Average	**52034**	**44**	**32831**	**0.084**	**0.133**
St dev	38576	51.4	8563.1	0.049	0.143

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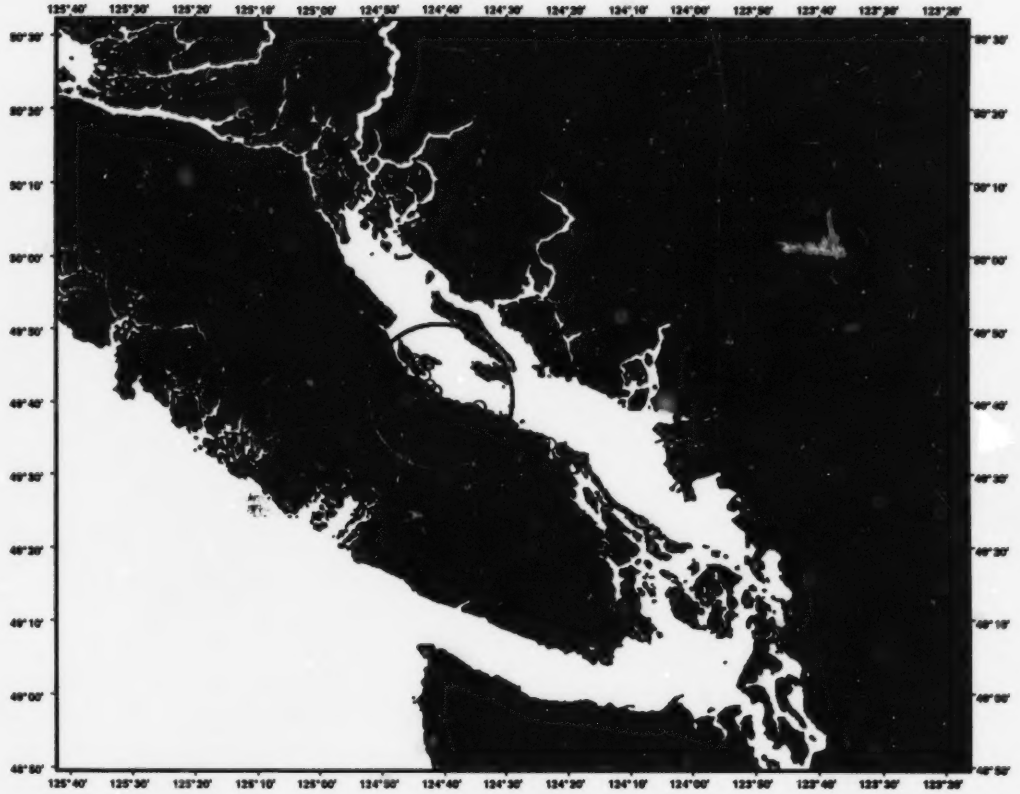

Figure 1.a) French Creek - Denman Island tag release sites for 1999.

Figure 1.b) Corresponding number of tags released at each tagging site.

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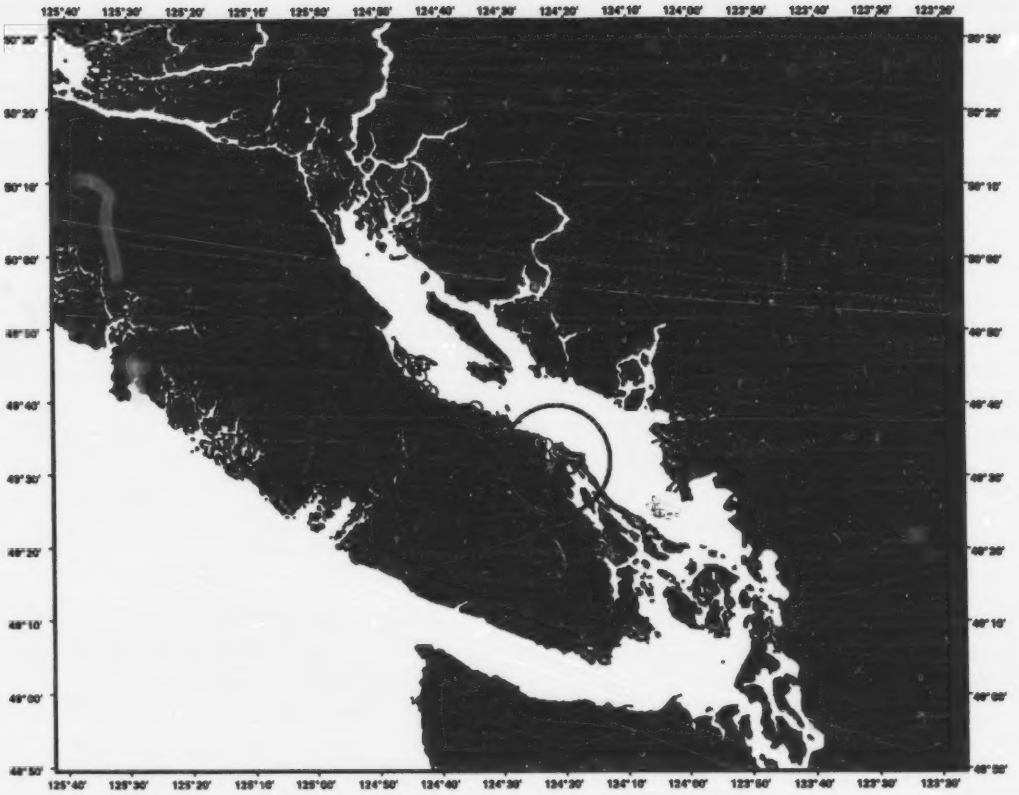

Figure 2.a) Nanaimo area tag release sites for 1999.

Figure 2.b) Corresponding number of tags released at each tagging site.

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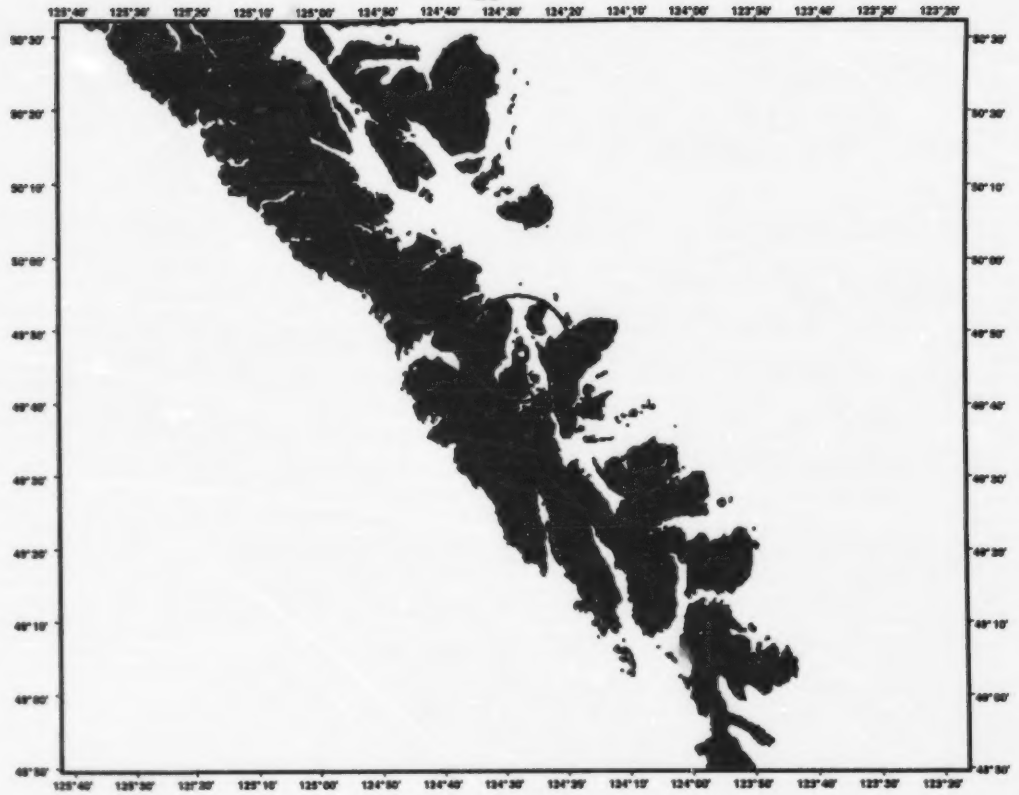

Figure 3.a) Queen Charlotte Islands tag release sites for 1999.

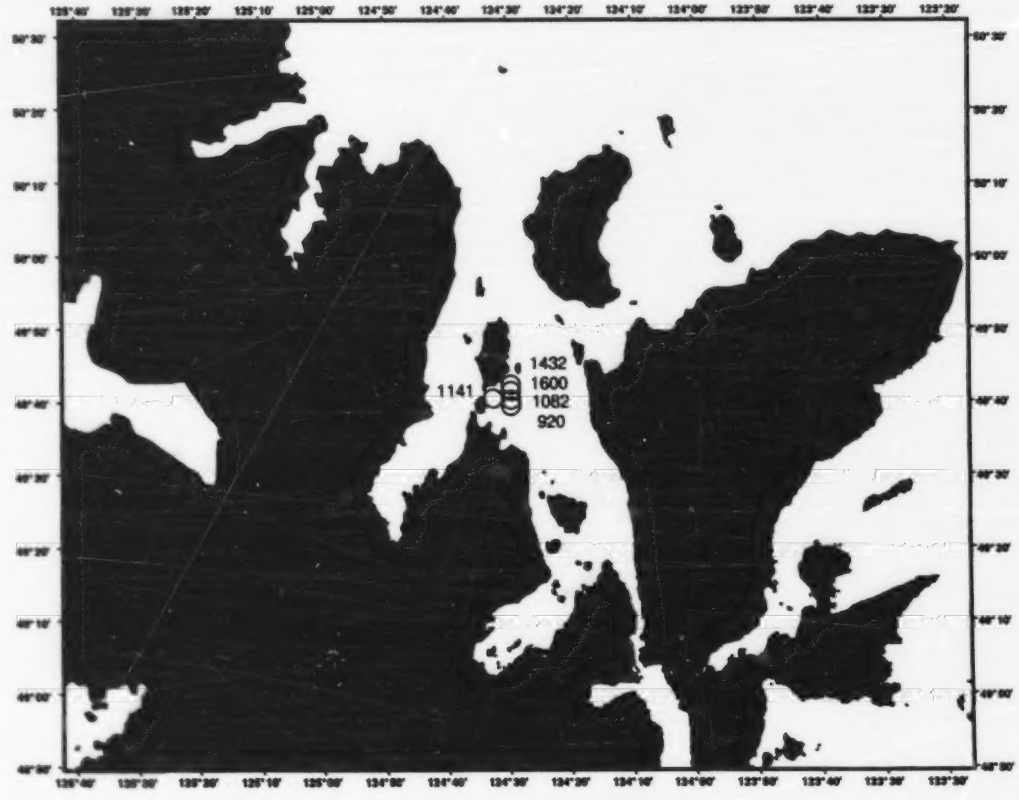

Figure 3.b) Corresponding number of tags released at each tagging site.

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Figure 4.a) 2000 roe fishery tag recovery sites of 1999 series 18-15-63, Phipps Pt (O tagging , ▲ – recovery locations).

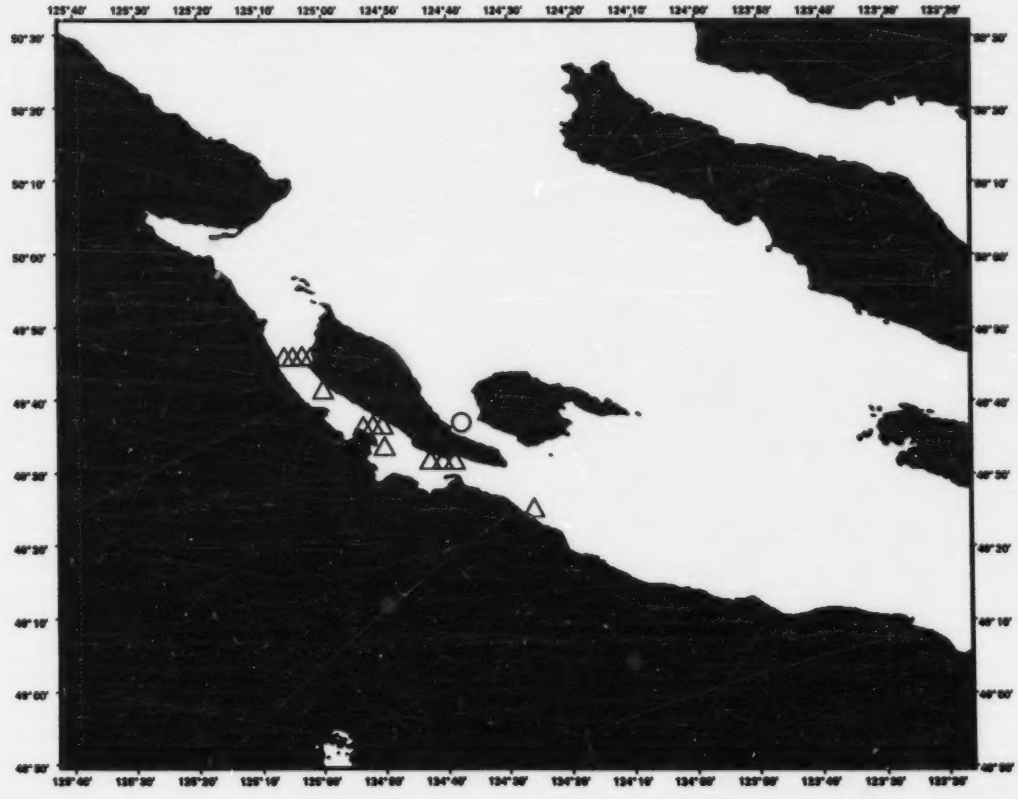

Figure 4.b) 2000 roe fishery tag recovery sites of 1999 series 18-08-56, Whalebone Pt (O tagging , ▲ – recovery locations).

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Figure 4.c) 2000 roe fishery tag recovery sites of 1999 series 18-12-35, Chrome Island (O tagging , ▲ – recovery locations).

Figure 4.d) 2000 roe fishery tag recovery sites of 1999 series 02-60-10, Bowser (O tagging , ▲ – recovery locations).

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Figure 4.e) 2000 roe fishery tag recovery sites of 1999 series 18-12-33 and 18-02-04, Qualicum Bay (O tagging , ▲ – recovery locations).

Figure 4.f) 2000 roe fishery tag recovery sites of 1999 series 08-16-11 and 02-19-27, French Creek (O tagging , ▲ – recovery locations).

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Figure 4.g) 2000 roe fishery tag recovery sites of 1999 series 18-12-34, McKay Pt (O tagging , ▲ – recovery locations).

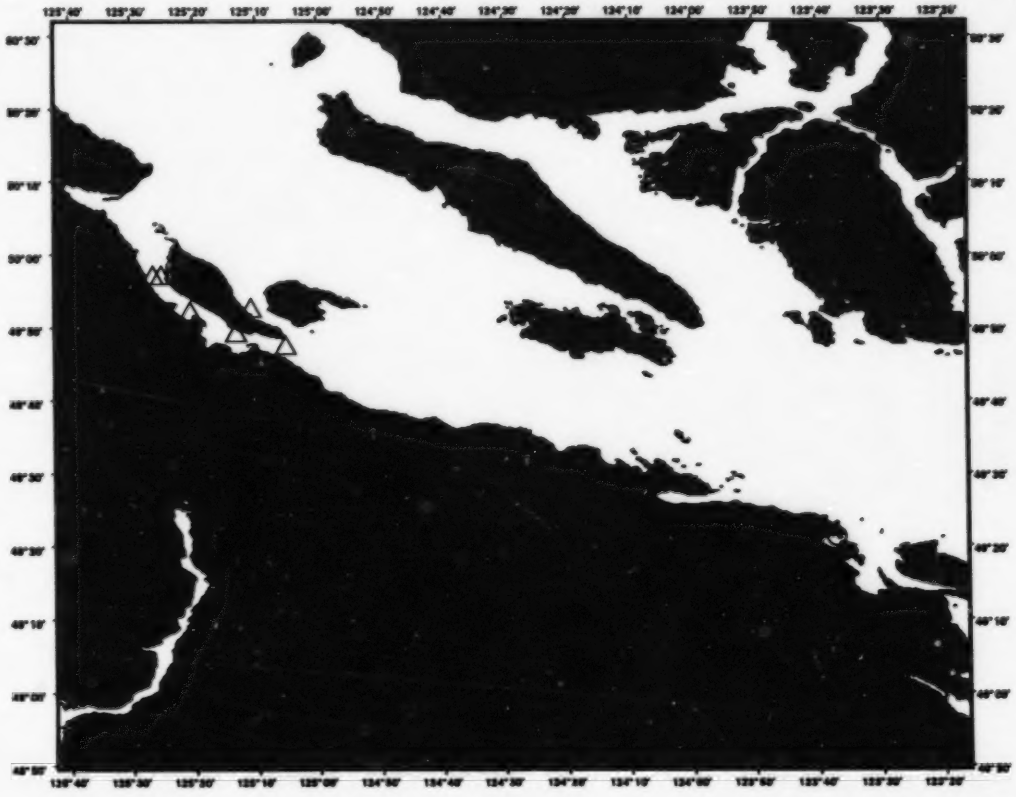

Figure 4.h) 2000 roe fishery tag recovery sites of 1999 series 02-63-44, Jesse Island (O tagging , ▲ – recovery locations).

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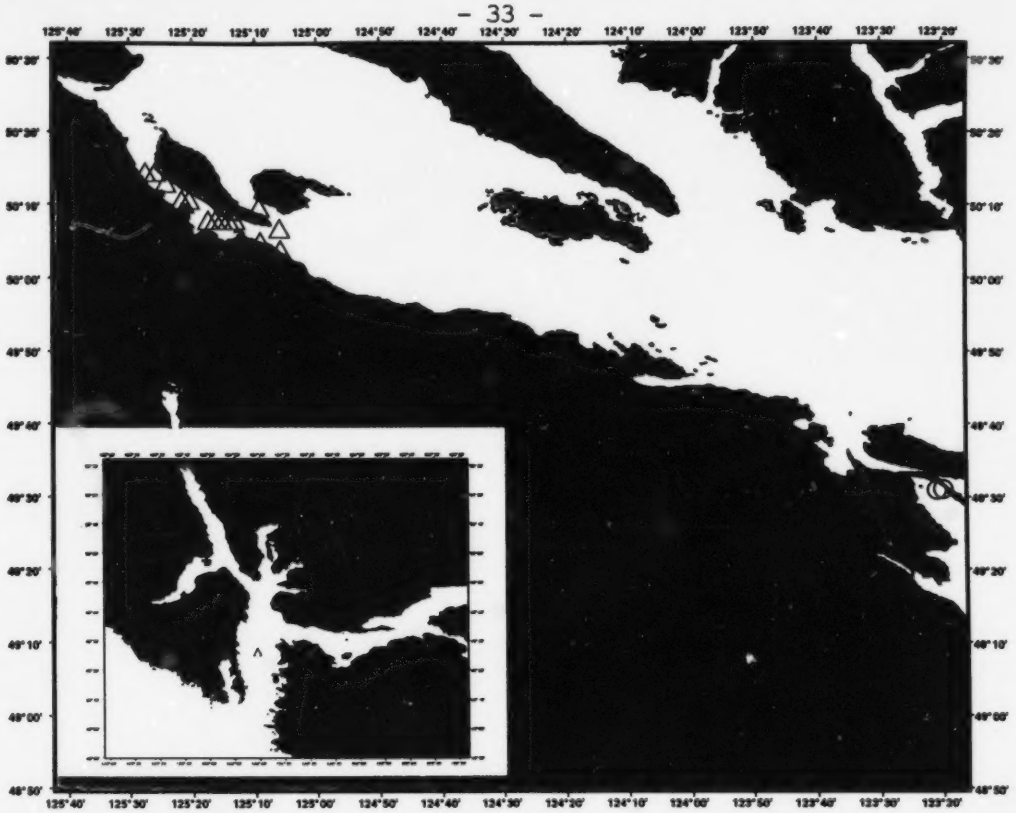

Figure 4.i) 2000 roe fishery tag recovery sites of 1999 series 18-12-07 and 08-16-09, Link Island (○ tagging , ▲ – recovery locations).

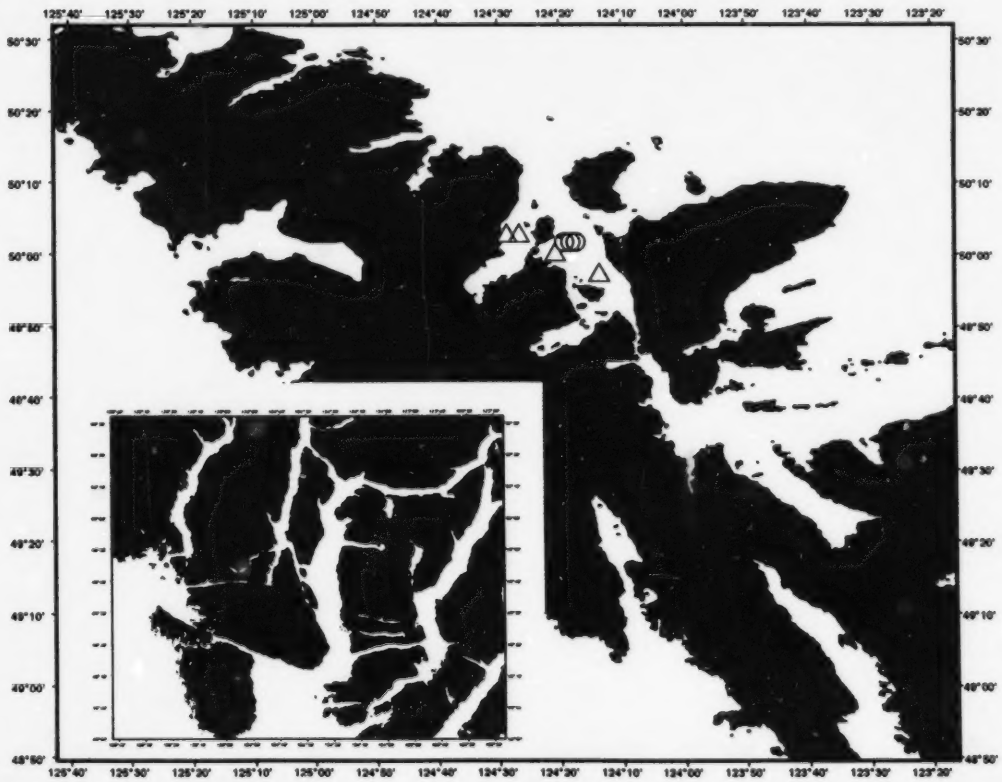

Figure 4.j) 2000 roe fishery tag recovery sites of 1999 series 18-14-16, 18-11-55, 18-18-34, Wanderer Island (○ tagging , ▲ – recovery locations).